

TOPIC 3

## Computer Hardware Basics

Computer is more than just a processor or screen. It is an integrated system whose components collaborate to execute complex analytical workflows.

### Central Processing Unit (CPU)

The CPU is the "brain" of the computer. It actually executes instructions organized into programs (software) that determine the computer's actions.

### Role in Biostatistics

- Executes statistical algorithms, such as regression, survival analysis, and Bayesian inference.
- Enables simulations for epidemiological modeling and clinical trial scenario projections.

### Role in Financial Engineering

- Runs high-speed option pricing models, Monte Carlo simulations, and algorithmic trading strategies.
- Determines execution latency in high-frequency trading (HFT) systems.

### Technical Insight

- Multi-core CPUs enable parallel computation of independent simulations (e.g., bootstrap resampling or Monte Carlo iterations).
- Vectorized instructions (SIMD) accelerate linear algebra operations in large cohort

or. portfolio datasets.

## Memory (RAM)

Random Access Memory (RAM) is fast, volatile, and relatively expensive. It temporarily stores:

- Active programs.
- Data currently processed.
- Intermediate results.

## Analytical Relevance

• **Biostatistics**: Holding large patient datasets or multi-dimensional matrices during computation-intensive survival or longitudinal analyses.

• **Financial Engineering**: Storing large Covariance Matrices, time series data and intermediate stages in stochastic simulations.

## Key Consideration

Insufficient RAM causes disk swapping, which drastically slows computations in both health and financial simulations.

## Mass Storage Devices

- Mass storage refers to slower, long-term memory that retains data between computational jobs.

### Examples:

- Hard Disk Drives (HDDs).
- Solid-State Drives (SSDs).
- Tape Drives (archival).

## Input Devices

Input devices deliver data and instructions into the system.

### Analytical Examples

- Biostatistics: Clinical trial data, Lab Measurements, Survey inputs.
- Financial Engineering: Market data feeds, Simulation Parameters, Scenario.

### Modern Considerations

Input increasingly arrives via digital pipelines

- APIs.
- Networked sensors.
- Electronic Data Capture (EDC) systems.

## Output Devices

Output devices - Monitors, Printers, dashboards - Visualize Computational results.

### Domain Examples

Biostatistics: Kaplan-Meier Plots, Epidemic Curves, gene expression heatmaps.

Financial Engineering: VaR reports, risk dashboards, real-time analytics.

### Analytical Insight

Clear output is essential for interpreting Multi-dimensional datasets or Model diagnostics.

## EX 1

This Code Measures how Computer architecture affects analytical Performance.

it benchmarks CPU speed using parallel Monte Carlo simulation, RAM efficiency using a large matrix operation, and storage performance through disk read/write tests. It prints these results and visualizes all three timings with annotated, color-coded subplots in one row.